PATENT SPECIFICATION

891,741

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COMPLETE SPECIFICATION

DRAWINGS ATTACHED

Improvements in or relating to Ropes

We, BRITISH NYLON SPINNERS LIMITED, Pontypool, Monmouthshire, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to ropes, and more particularly to ropes composed of synthetic linear polymeric textile materials, wherein the strands thereof are parallel to each other or substantially so.

Traditionally ropes are made from yarn constructed of fibres of vegetable origin. Since the latter fibres are of finite or limited length (except possibly in the case of silk, but the long silk filaments would be far too expensive for most purposes), the fibres have to be twisted so that they cohere together so as to form a yarn of indefinite length. Numerous fibres have been used for this purpose, especially hemp, but in the last decade use had begun to be made in rope construction of the relatively new synthetic linear polymeric filaments. Examples of synthetic linear polymers which are useful for making filaments are as follows:—

polyhexamethylene adipamide
polyethylene terephthalate
stereospecific polypropylene
poly-epsilon caprolactam
poly-kappa-aminoundecanoic acid
linear polyethylene

Such filaments are characterised by the possession of many textile properties which are superior to those of the textile filaments of vegetable origin. For example, the synthetic filaments are noted for their high tenacity. These filaments have accordingly been found most attractive as rope-making materials.

Nevertheless, despite the availability of the synthetic linear polymeric filaments in practically endless lengths, they have hitherto been fabricated into ropes in accordance with the traditional twisting technique, originally devised to cope with natural fibres, that is to say, with filaments of short length. Although the resulting ropes are of excellent quality, the traditional method of construction does not permit the advantages of the synthetic fibres to be fully utilised.

The object of the present invention is more efficiently to apply the outstanding properties of the now available synthetic linear filaments by providing a novel method of rope construction wherein the filaments lie parallel to one another or substantially so. Thus, instead of making the rope by (a) twisting fibres to form rope yarn (b) twisting the yarns to form strands and (c) twisting the strands into rope, according to the invention the rope yarns, each of which consists of a number of continuous filaments very slightly twisted together, are associated together parallel to each other and secured by tape, in the following manner.

The heart or core of the rope consists of a bundle of parallel yarn bound together with tape which is twisted about said bundle in the form of a spiral and adhesively affixed to the periphery thereof. Surrounding this taped heart or core is a concentric layer of parallel yarns, bound together with a further tape in the form of a spiral of opposite twist to the last and likewise adhesively affixed. The aforesaid concentric layer is surrounded in its turn by at least one further similar concentric layer secured by tape the twist of which is again reversed.

A further feature of the invention comprises the grouping together of the yarns, assumed in this case to be of equal size (and of circular cross-section), in the theoretical geometrical pattern, whereby the densest packing is procured. In this arrange-

[Price

ment, the cross-section of the group of yarns is assumed to be hexagonal in outline, and the centre yarn (which constitutes the first layer) is surrounded by successive concentric layers of yarns containing 6 yarns, then 12 yarns, then 18 yarns, etc., the number of yarns in n layers of this hexagonal arrangement being given by the expression $(1-3n+3n^2)$.

Accordingly the invention consists of a rope comprising a number of rope yarns associated together in parallel spatial relationship to each other, wherein the heart or core of the rope is a bundle of parallel rope yarns bound together with tape which is twisted about said bundle in the form of a spiral and adhesively affixed to the periphery thereof, and surrounding this taped heart or core is a concentric layer of parallel rope yarns, bound together by means of a further tape in the form of a spiral of opposite twist to that of the aforementioned tape and likewise adhesively affixed, which concentric layer is surrounded in its turn by at least one further similar concentric layer of parallel rope yarns secured by tape the twist of which is opposite to that of the tape next below it, each rope yarn consisting of a number of continuous synthetic linear polymeric filaments twisted together with a very low degree of twist.

Preferably the rope of this invention consists of a bundle of 37 rope yarns placed in parallel relationship and packed in the hexagonal arrangement described above, the central 7 yarns being secured with tape, and surrounded by a layer of 12 yarns also taped, which layer is covered in turn by a further layer of 18 yarns likewise taped. The yarns are all equal-sized in the geometrical arrangement.

The tape used to secure the layers of rope yarns may desirably itself be a fabric woven from yarn consisting of a synthetic linear polymeric filament, e.g. polyhexamethylene adipamide.

Suitable adhesives in the case in which both the rope yarns and the tape consist of a polyamide such as polyhexamethylene adipamide are (the parts being parts by weight):—

Solution of N-methoxymethylpolyhexamethylene adipamide in ethanol;

Solution of polyhexamethylene adipamide in aqueous phenol;

Solution of the interpolyamide from hexamethylene diammonium adipate (2 parts) and epsilon-caprolactam (3 parts) in thrice its weight of a (1 part : 1 part) mixture of trichloroethylene and methanol;

Aqueous phenol solution;

Aqueous formic acid solution;

Solution of polyhexamethylene adipamide in a mixture of anhydrous calcium chloride (1 part) and methanol (3 parts);

Solution of polyhexamethylene adipamide in 2-nitro-1-ethanol.

The flexibility of the present rope depends on the angle of the spiral of the tapes and on their width and thickness. It is preferred that the angle between the spiral and the axis of the rope should be sufficiently small so that the tape only covers less than 50% of the visible surface area of the rope yarn bundle surrounded thereby.

The outermost taping is preferably carried out by the application of two tapes of opposite twist. If desired, there may be applied to the resulting rope a final coating of polyvinyl chloride or rubber, and/or braid.

The present rope construction has the advantage of permitting the full strength of the rope yarns to be utilised. Inter-yarn friction during extension under load is moreover practically avoided, as are also shear stresses when the rope is under strain.

In Figure 1 of the diagrammatic drawings accompanying the Provisional Specification is seen the core or heart of the rope 1, which is secured by the tape 2, and consists of a parallel assemblage of rope yarns 3, which are depicted as unravelled at the end for clarity. It will be observed that 12 ends of rope yarn are shown in the core. Around the taped core a concentric layer of parallel rope yarns 4 is bound by the tape 5.

Figure 2 of the drawings, which is a continuation of Figure 1, shows a further and final concentric layer of rope yarns 6, secured by two tapes 7 and 8 wound spirally with opposite twist. It will be observed that the tapes have the following twists:—

tape 2 Z twist
tape 5 S twist
tape 7 Z twist
tape 8 S twist

Figure 3 of the drawings illustrates a cross-section of a central core of 7 yarns (marked 9) surrounded by tape 10 and a concentric layer of 12 yarns (marked 11); this arrangement of rope yarns shows the geometrical packing.

The following embodiment of the invention is intended by way of illustration not limitation.

A rope is constructed as follows: 12 filaments of polyhexamethylene adipamide yarn, each of 840 denier, are twisted together with ½ turn Z per inch. The resulting denier is ca. 10000. 4 Ends of the resulting thread are twisted together with 2 turns per inch S twist. The resulting yarn, which has a denier of 40,000, constitutes the rope yarn. Seven of the above rope yarns are assembled together in parallel relationship to form the

core of the rope and bound with tape which is woven from 70 denier filament yarn of polyhexamethylene adipamide. The tape is 0.25" wide and 0.025" thick and is wetted with an ethanolic solution of N-methoxymethylpolyhexamethylene adipamide so that it adheres well to the yarns of the core, and also to the concentric layer of yarns next to be applied. The latter number 12, and the cross-section of the arrangement of yarns corresponds to that shown in Figure 3 of the drawings. The aforesaid concentric layer is taped as before, but with opposite twist, and a further concentric layer of 18 rope yarns applied. The resulting rope structure is finally bound with two tapes, as described above, wound in opposite directions.

WHAT WE CLAIM IS:—

1. A rope comprising a number of rope yarns associated together in parallel spatial relationship to each other, wherein the heart or core of the rope is a bundle of parallel rope yarns bound together with tape which is twisted about said bundle in the form of a spiral and adhesively affixed to the periphery thereof, and surrounding this taped heart or core is a concentric layer of parallel rope yarns, bound together by means of a further tape in the form of a spiral of opposite twist to that of the aforementioned tape and likewise adhesively affixed, which concentric layer is surrounded in its turn by at least one further similar concentric layer of parallel rope yarns secured by tape the twist of which is opposite to that of the tape next below it, each rope yarn consisting of a number of continuous synthetic linear polymeric filaments twisted together with a very low degree of twist.

2. A rope as claimed in Claim 1, wherein the rope yarns are equal-sized and packed in the hexagonal arrangement hereinbefore described, the central 7 yarns being secured with tape, and surrounded by a layer of 12 yarns also taped, which layer is covered in turn by a further layer of 18 yarns and so forth, the total number of yarns in n layers (the central 7 yarns counting as 2 layers) being given by the expression $1-3n+3n^2$.

3. A rope as claimed in Claim 2, wherein the number of layers is 4, the rope accordingly consisting of a bundle of 37 rope yarns.

4. A rope as claimed in any previous claim wherein the rope yarns consist of polyhexamethylene adipamide.

5. A rope as claimed in Claim 4 wherein the tape used to secure the layers of rope yarns is a fabric woven from yarn consisting of polyhexamethylene adipamide.

6. A rope as claimed in any previous claim wherein the angle between the spiral of the tapes and the axis of the rope is sufficiently small so that each tape only covers less than 50% of the visible surface area of the rope bundle surrounded thereby.

S. CLARK,
Chartered Patent Agent.

PROVISIONAL SPECIFICATION

Improvements in or relating to Ropes

We, BRITISH NYLON SPINNERS LIMITED, of Pontypool, Monmouthshire, a British Company, do hereby declare this invention to be described in the following statement:—

This invention relates to ropes, and more particularly to ropes composed of synthetic linear polymeric textile materials, wherein the strands thereof are parallel to each other or substantially so.

Traditionally ropes are made from yarn constructed of fibres of vegetable origin. Since the latter fibres are of finite or limited length (except possibly in the case of silk, but the long silk filaments would be far too expensive for most purposes, the fibres have to be twisted so that they cohere together so as to form a yarn of indefinite length. Numerous fibres have been used for this purpose, especially hemp, but in the last decade use had begun to be made in rope construction of the relatively new synthetic linear polymeric filaments. Examples of synthetic linear polymers which are useful for making filaments are as follows:—

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Such filaments are characterised by the possession of many textile properties which are superior to those of the textile filaments of vegetable origin. For example, the synthetic filaments are noted for their high tenacity. These filaments have accordingly been found most attractive as rope-making materials.

Nevertheless, despite the availability of the synthetic linear polymeric filaments in practically endless lengths, they have hitherto been fabricated into ropes in accordance with the traditional twisting technique, originally devised to cope with natural fibres, that is to say, with filaments of short length. Although the resulting ropes are of excellent quality, the traditional method of construction does not permit the advantages of the synthetic fibres to be fully utilised.

The object of the present invention is more efficiently to apply the outstanding properties

of the now available synthetic linear filaments by providing a novel method of rope construction wherein the filaments lie parallel to one another or substantially so. Thus, instead of making the rope by (a) twisting fibres to form rope yarn (b) twisting the yarns to form strands and (c) twisting the strands into rope, according to the invention the rope yarns, each of which consists of a number of continuous filaments very slightly twisted together, are associated together parallel to each other and secured by tape, in the following manner.

Thus the heart or core of the rope consists of a bundle of parallel yarns bound together with tape which is twisted about said bundle in the form of a spiral and adhesively affixed to the periphery thereof. Surrounding this taped heart or core is a concentric layer of parallel yarns, bound together with a further tape in the form of a spiral of opposite twist to the last and likewise adhesively affixed. The aforesaid concentric layer is surrounded in its turn by at least one further similar concentric layer secured by tape the twist of which is again reversed.

A further feature of the invention comprises the grouping together of the yarns, assumed in this case to be of equal size (and of circular cross-section), in the theoretical geometrical pattern, whereby the densest packing is procured. In this arrangement, if the cross-section of the group of yarns is assumed to be hexagonal in outline, then the centre yarn would be surrounded by successive concentric layers of yarns containing 6 yarns, then 12 yarns, then 18 yarns, etc., the number of yarns in layers being given by the expression $(1-3n+3n^2)$.

Accordingly the invention consists of a rope comprising a number of rope yarns associated together in parallel spatial relationship to each other, wherein the heart or core of the rope is a bundle of parallel rope yarns bound together with tape which is twisted about said bundle in the form of a spiral and adhesively affixed to the periphery thereof, and surrounding this taped heart or core is a concentric layer of parallel rope yarns, bound together by means of a further tape in the form of a spiral of opposite twist to that of the aforementioned tape and likewise adhesively affixed, which concentric layer is surrounded in its turn by at least one further similar concentric layer of parallel rope yarns secured by tape the twist of which is opposite to that of the tape next below it, each rope yarn consisting of a number of continuous synthetic linear polymeric filaments twisted together with a very low degree of twist.

Preferably the rope of this invention consists of a bundle of 37 rope yarns placed in parallel relationship and geometrically packed in the arrangement described above, the central 7 yarns being secured with tape, and surrounded by a layer of 12 yarns also taped, which layer is covered in turn by a further layer of 18 yarns likewise taped. The yarns are all equal-sized in the geometrical arrangement.

The tape used to secure the layers of rope yarns may desirably itself be a fabric woven from yarn consisting of a synthetic linear polymeric filament, e.g. polyhexamethylene adipamide.

Suitable adhesives in the case in which both the rope yarns and the tape consist of a polyamide such as polyhexamethylene adipamide are (the parts being parts by weight):—

- Solution of N-methoxymethylpolyhexamethylene adipamide in ethanol;
- Solution of polyhexamethylene adipamide in aqueous phenol;
- Solution of the interpolyamide from hexamethylene diammonium adipate (2 parts) and epsilon-caprolactam (3 parts) in thrice its weight of a (1 part : 1 part) mixture of trichloroethylene and methanol;
- Aqueous phenol solution;
- Aqueous formic acid solution;
- Solution of polyhexamethylene adipamide in a mixture of anhydrous calcium chloride (1 part) and methanol (3 parts);
- Solution of polyhexamethylene adipamide in 2-nitro-1-ethanol.

The flexibility of the present rope depends on the angle of the spiral of the tapes and on their width and thickness. It is preferred that the angle between the spiral and the axis of the rope should be sufficiently small so that the tape only covers less than 50% of the rope yarn bundle surrounded thereby.

The outermost taping is preferably carried out by the application of two tapes of opposite twist. If desired, there may be applied to the resulting rope a final coating of polyvinyl chloride or rubber, and/or braid.

The present rope construction has the advantage of permitting the full strength of the rope yarns to be utilised. Inter-yarn friction during extension under load is moreover practically avoided, as are also shear stresses when the rope is under strain.

The invention further contemplates the inclusion of other materials e.g. polyvinyl chloride, synthetic rubber, natural rubber in the ropes to vary the size of the rope for a given strength. The density of the rope may be adjusted in a similar manner, for, depending upon the purpose for which the rope is to be employed, it may be desirable for the rope to float or sink.

In Figure 1 of the accompanying diagram-

matic drawings is seen the core or heart of the rope 1, which is secured by the tape 2, and consists of a parallel assemblage of rope yarns 3, which are depicted as unravelled at the end for clarity. It will be observed that 12 ends of rope yarn are shown in the core. Around the taped core a concentric layer of parallel rope yarns 4 is bound by the tape 5.

Figure 2 of the drawings, which is a continuation of Figure 1, shows a further and final concentric layer of rope yarns 6, secured by two tapes 7 and 8 wound spirally with opposite twist. It will be observed that the tapes have the following twists:—

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The following embodiment of the invention is intended by way of illustration not limitation.

A rope is constructed as follows: 12 filaments of polyhexamethylene adipamide yarn, each of 840 denier, are twisted together with $\frac{1}{2}$ turn Z per inch. The resulting denier is ca. 10000. 4 Ends of the resulting thread are twisted together with 2 turns per inch S twist (or Z?). The resulting yarn, which has a denier of 40,000, constitutes the rope yarn. Seven of the above rope yarns are assembled together in parallel relationship to form the core of the rope and bound with tape which is woven from 70 denier filament yarn of polyhexamethylene adipamide. The tape is 0.25" wide and 0.025" thick and is wetted with an ethanolic solution of N-methoxymethylpolyhexamethylene adipamide so that it adheres well to the yarns of the core, and also to the concentric layer of yarns next to be applied. The latter number 12, and the cross-section of the arrangement of yarns corresponds to that shown in Figure 3 of the drawings. The aforesaid concentric layer is taped as before, but with opposite twist, and a further concentric layer of 18 rope yarns applied. The resulting rope structure is finally bound with two tapes, as described above, wound in opposite directions.

S. CLARK,
Chartered Patent Agent.

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Published at The Patent Office, 25 Southampton Buildings, London. W.C.2, from which copies may be obtained.

891,741 PROVISIONAL SPECIFICATION
1 SHEET

This drawing is a reproduction of the Original on a reduced scale.

FIG. 1.

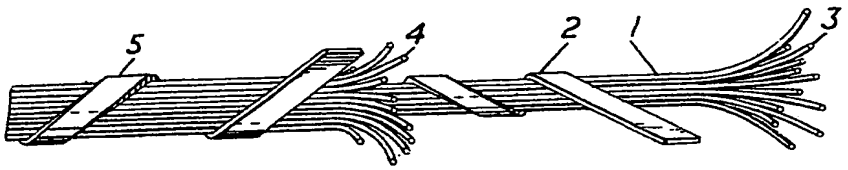

FIG. 2.

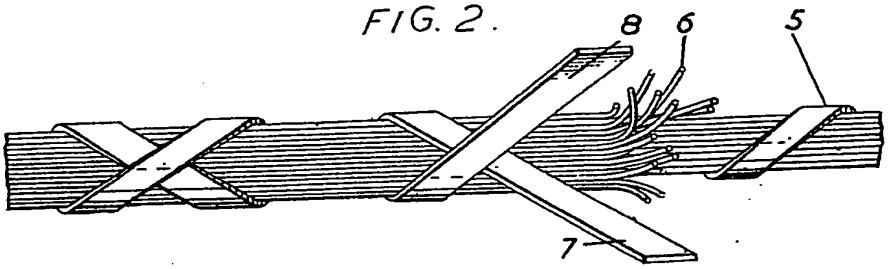

FIG. 3.